



Crowd Behavior Modeling in COMBAT XXI

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Agenda

- Motivation
- Crowd modeling
- Digital pheromone systems
- COMBAT XXI
- Project description
- Questions

Motivation

- Context important for military operations.
 - Physical constraints.
 - Terrain, weather, time of day, visibility, etc.
 - Social functionality constraints.
 - Cultural artifacts (religious buildings, hospitals, schools, etc.)
 - Indigenous Population
 - The people themselves.
 - Customs, social rules, etc.

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Our goal is to address some aspects of this problem.

Crowd Modeling

- Representation requirements:
 - Large numbers of people – ideally should be much larger than the force being represented.
 - Dynamic behaviors – no scripting.
 - “Realistic” movement and aggregation.
 - Reactive – behaviors can change based on what force agent do.
 - Coordinated behaviors
 - Communication.
 - Memory.
- Usage requirements:
 - Computationally efficient
 - Easy to set up

Digital Pheromone Models

- Derived from natural systems of self organization.
- Based on mechanism used in insect colonies to coordinate activity.
- Pheromone based models used in many areas:
 - Manufacturing process modeling.
 - Cell phone network optimization.
 - Autonomous vehicle modeling.

A Digital Pheromone System (DPS)

- Pheromone (scent)
 - Flavor
 - Dispersion
 - Evaporation
- Can be deposited and sensed by agents.
- Deposited at locations in environment based on local conditions and entity state.
- Pheromone provides a way for entities to communicate and also to keep a collective memory.
- Only need very simple agents
 - Sense
 - Deposit
 - Simple state transition based on pheromone strength
- Simple Cellular Automata based model for the pheromone infrastructure.

COMBAT XXI Background

- Target simulation is COMBAT XXI
 - Closed form analytical model
 - Stochastic
 - Agent based model
 - Developed/used Army and Marine Corps
 - TRADOC Analysis Center
 - Marine Corps Combat Development Command
 - Brigade and below studies
 - Scenario sizes ranges ~50 – 10,000+ entities
 - Typical sizes – low 100s to 1500
 - Effects model
- Several other projects at NPS involve COMBAT XXI

Past Pheromone Work

- Demonstration of Pheromone based reactive behaviors.
 - TRAC-MTRY/ALTARUM
 - Demonstrated feasibility of DP approach.
 - Loosely coupled to model.

Objective of Current Work

- Build a Pheromone Layer into COMBAT XXI
 - Tightly connected to native environment
- Add behavior hooks to the Pheromone Layer
 - Allow agents in the model to access the PL as part of the general behavior mechanism
- Demonstrate pheromone based “ambient” behavior.
 - e.g. having entities move from home to a “market”, spend time there and then return home.

Status

- Basic pheromone synthetic environment complete.
 - Connected to COMBAT XXI core code.
 - Standalone component.
- Simple behavior infrastructure developed.
- Sample scenarios created to show basic functionality.

Future Work

- Performance improvements
 - Optimize code to reduce computational load
- Interface enhancements
 - Develop tools to allow for more intuitive control of parameters
 - Better visualization tools
- Behavior refinement
 - Combine ambient and reactive behaviors

Questions ?

